
FLOOD PROOFING

Techniques, Programs, and References



May 2000



US Army Corps
of Engineers®

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE MAY 2000		2. REPORT TYPE		3. DATES COVERED 00-00-2000 to 00-00-2000	
4. TITLE AND SUBTITLE Flood Proofing: Techniques, Programs, and References				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers, Omaha District, 1616 Capitol Avenue Ste 9000, Omaha, NE, 68102				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 31	19a. NAME OF RESPONSIBLE PERSON
a REPORT unclassified	b ABSTRACT unclassified	c THIS PAGE unclassified			

FLOOD PROOFING TECHNIQUES, PROGRAMS, AND REFERENCES

Preface

Flood proofing is an important Flood Plain Management technique that can be used to reduce flood damage to buildings and their contents.

This report addresses the approaches to flood proofing and government flood proofing programs, references, and terminology. It presents a general overview of flood proofing techniques and provides the reader information on government agencies that offer more specific assistance and publications containing detailed flood proofing information.

The first chapter introduces the reader to flood proofing by explaining its basic concept, general approaches, and specific techniques.

Chapters 2 and 3 discuss major sources of flood proofing assistance government programs. Chapter 2 describes the various types of government flood proofing activities and Chapter 3 discusses specific flood proofing programs of government agencies.

Publications are important sources of assistance on flood proofing. Basic reference publications on floodproofing are described in Chapter 4. Chapter 5 explains how to locate additional flood proofing publications from the Floodplain Management Resource Center. Chapter 6 provides a glossary of flood proofing terms.

Page 20 contains two matrices that may prove useful to the reader. The top matrix shows the contents of recommended flood proofing publications. The bottom matrix shows the various types of flood proofing assistance offered by selected government agencies.

This report has been prepared under the direction of the U.S. Army Corps of Engineers National Flood Proofing Committee as part of its ongoing efforts to assist government agencies and property owners in understanding and using flood proofing techniques.

FLOOD PROOFING TECHNIQUES, PROGRAMS, AND REFERENCES

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CHAPTER 1 INTRODUCTION TO FLOOD PROOFING

Flood proofing is a process for preventing or reducing flood damages to the structure and/or to the contents of buildings located in flood hazard areas. For the most part, it involves altering or changing existing properties. However, it can be incorporated into the design and construction of new buildings. There are three general approaches to flood proofing:

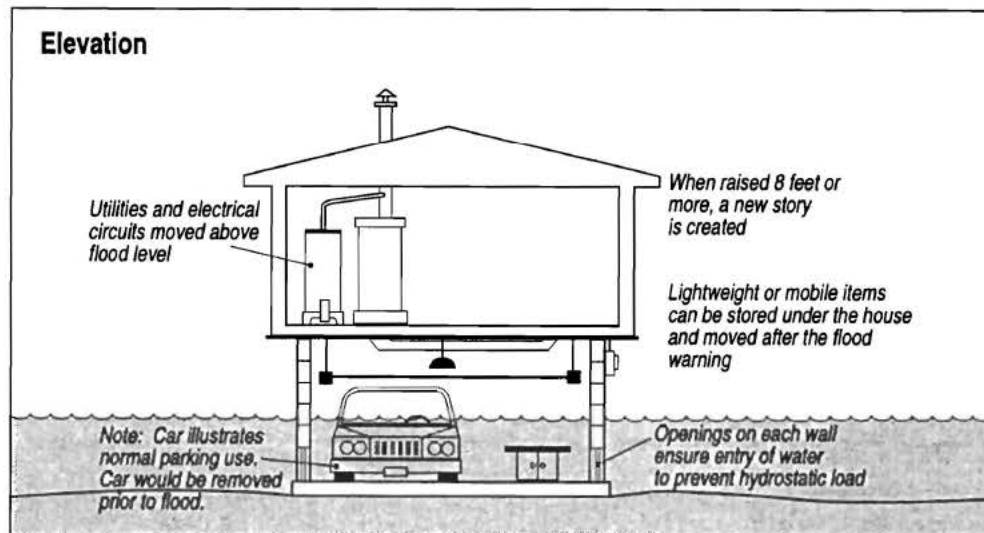
1. Raising or moving the structure
2. Constructing barriers to stop floodwater from entering the building
3. Wet Flood Proofing

These approaches are explained in greater detail in the following paragraphs along with some additional flood proofing items to consider before and during a flood.

• Raising or Moving the Structure

Raising or moving a structure so that floodwaters cannot reach damageable portions of it is an effective flood proofing approach. One technique is to raise the structure in place so that the lowest floor is above the expected level of floodwaters. This is commonly referred to as "elevation." The structure is jacked up and set on cribbing and a new or extended foundation is constructed underneath the structure.

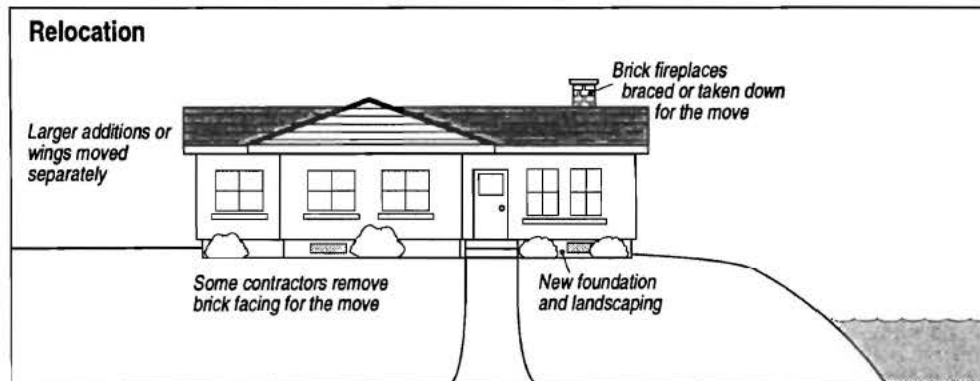
In areas where flooding is likely to have high velocities or waves, elevation on piles or columns without enclosing the lower area is the only recommended flood proofing technique.



Cost is an important factor to consider in elevating structures. Lighter wood frame buildings are easier and cheaper to raise than masonry buildings. Masonry buildings not only are more expensive to raise, but are susceptible to cracks. If homeowners opt for elevation of the building, they must not then place contents or materials susceptible to flood damage on the new lower level.

A second technique is to move the building to another location where floodwaters cannot reach it. This technique is commonly referred to in flood proofing literature as "relocation." Relocation of the structure can be to a flood-free location on the same lot or to another flood-free location. There are many qualified contractors experienced in relocating or elevating buildings.

Relocation is an appropriate technique in high hazard areas where continued occupancy is unsafe, where owners want to be free from flood worries, or where communities have determined that the open space gained could be used for more appropriate floodplain activities.

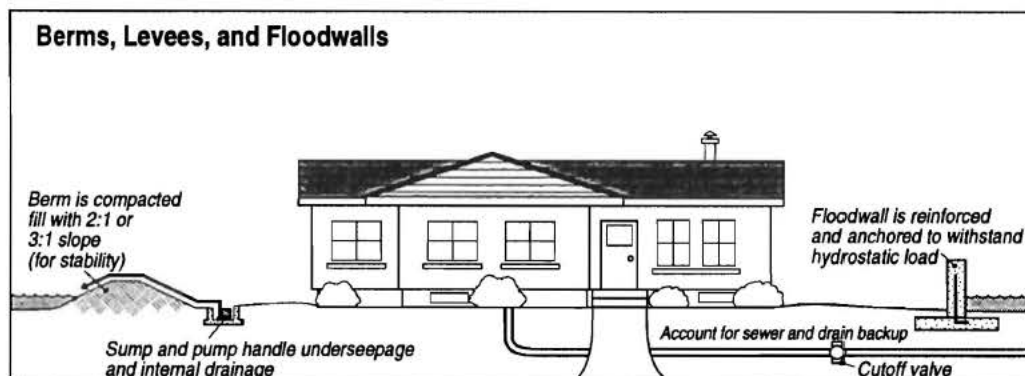


A major concern in evaluating the feasibility of relocation is cost. Acquiring a new lot, constructing a new foundation, and paying for moving contractors and new landscaping must be considered. There are several government programs that provide financial assistance or that acquire floodplain properties. Further information on these programs is available in Chapter 3.

• Constructing Barriers

Constructing barriers is an effective approach used to stop floodwaters from reaching the damageable portions of structures. There are two techniques employed in constructing barriers. The first technique involves constructing free-standing barriers that are not attached to the structure. The three primary types of free-standing barriers used to reduce flood damages are berms, levees, or floodwalls.

A berm is typically an earthen structure, constructed from local compacted fill, that stops flood water from reaching the building. To be effective over periods of time, berms must be constructed out of suitable materials (i.e. impervious soils) and with correct side slopes.



Levees, which are similar to berms, are also earthen structures of compacted local fill. Levees are usually constructed along riverbanks to prevent the flood waters from spilling over and flooding structures. Berms, on the other hand, serve the same purpose but usually are constructed closer to the structures themselves. Both berms and levees are generally appropriate for flood proofing a home where floodwaters are less than six feet deep. Levees can be constructed in areas where floodwaters exceed six feet deep, but the cost and the land area required for these levees usually make them impractical for the average homeowner.

Floodwalls are usually constructed out of reinforced concrete and anchored into the ground. Floodwalls, because of their greater cost, would normally be considered only on lots that are too small to have room for berms or levees or where flood velocities may erode earthen berms or levees. Other considerations such as

aesthetics and possible obstructions such as trees, etc., would also cause a homeowner to consider floodwalls rather than a berm or levee. Berms, levees, and floodwalls may not be appropriate for homes with basements since they are more susceptible to underseepage.

The second technique that can be used to construct a barrier against floodwaters is known as "dry flood proofing." With this technique, a building is sealed so that floodwaters cannot get inside. All areas below the flood protection level are made watertight. Walls are coated with waterproofing compounds or impermeable sheeting. Openings such as doors, windows, sewer lines, and vents are closed with permanent closures or removable shields, sandbags, valves, etc.



This flood proofing technique is only appropriate where floodwaters are less than three feet since most walls and floors in buildings will collapse under higher water levels. A professional engineer should be consulted when considering dry flood proofing since threat of collapse from hydrostatic pressure is a major concern with this technique. The dry flood proofing technique is not as successful on buildings with crawl spaces or basements since those structures are difficult to protect from underseepage. Finally, dry flood proofing is frequently used where there is insufficient space for a berm or levee. Some of the disadvantages of this technique are that many waterproofing compounds are not made to withstand the pressures of the water and will deteriorate over time. Also, closures on windows and doorways are dependent on adequate warning time for installation, as well as the presence of someone to install them correctly.

• Wet Flood Proofing

The third overall approach to flood proofing involves modifying a structure to allow floodwaters inside, but ensuring that there is minimal damage to the building's structure and to its contents. This type of protection is called "wet flood proofing."

Wet flood proofing allows the floodwaters to enter the structure. The building is modified so that utilities and furnaces are protected or relocated to an area above the anticipated flood level. Wet flood proofing is often used when dry flood proofing is not possible or is too costly.



Wet flood proofing is generally appropriate in cases where an area is available above flood levels to which damageable items can be relocated or temporarily stored. This approach is also appropriate for structures with basements and where other flood proofing measures will not be effective.

There are a number of factors to be considered in wet flood proofing a structure. For example, moving contents is dependent on adequate warning time and the action of someone who knows what to do. Flooding areas that contain sources of electricity or hazardous materials creates a safety hazard. Also, after the flood, there will still be the need for clean up when wet flood proofing is employed.

● **Additional Considerations**

Basement Protection

Flooding in basements and the lower levels of split-level houses is especially difficult to prevent. These areas are susceptible to seepage under berms, floodwalls, or dry flood proofed walls. Flooding of below-grade areas may occur through sewer pipes and drainage sumps, which are direct connections to flooded areas or from high groundwater caused by flooding. The basic sources of basement flooding and ways to prevent that flooding vary according to the type of flooding.

The first source of flooding in basements is failure or overload of the subdrainage system's sump pump. Installing alternate power sources, improving pump maintenance, and adding or increasing the size or number of pumps could eliminate this source of flooding.

Water backing up from sewer lines represents a second source of basement flooding. This could be eliminated by installing in-line valves or check (oneway) valves, installing standpipes, or converting the sewer system to an overhead sewer system.

Seepage through cracks in the walls, a third source of basement flooding, may be eliminated by sealing the walls with waterproofing compounds that are available commercially.

The fourth source of basement flooding is surface water flooding. Sealing basement windows and other above ground openings could prevent surface flooding from entering a basement.

In cases where flooding causes high groundwaters, hydrostatic pressures are usually too great to allow dry flood proofing a basement. Therefore, wet flood proofing by moving basement equipment and contents and allowing the water to enter the basement is often the only available means of reducing damages (*see Wet Flood Proofing*).

Emergency Measures

Emergency measures are temporary and usually implemented after a flood warning is issued. They are not permanent flood proofing installations and they require removal and clean-up after floodwaters have receded. Emergency measures fall into two basic categories: keeping the water out of the structure and protecting or moving damageable contents.

The most common measure used to keep water out of the structure is by erecting a sandbag wall. This requires a considerable amount of time, money, and manpower. Other temporary barriers can be erected with sand, rock, and lumber provided they are made watertight with impermeable sheeting.

Contents are best protected by moving them to higher floors of the structure or to higher ground. Some commercial establishments have modified their equipment by installing quick utility disconnects and placing them on pallets so that they may be easily moved on short notice.

Emergency measures are only effective if there is sufficient warning time to implement them. They may also be used to temporarily supplement a flood proofing technique where floodwaters will exceed the design level of the permanent measure. An example is sandbagging the top of a floodwall or levee.

General Cautions Applicable to Flood Proofing

Some cautions always should be considered in flood proofing. These include:

- **Flood proofed buildings should NEVER be occupied during a flood!** This is hazardous and life-threatening. Flooding conditions can change without warning and flood proofing installations can fail rapidly without allowing occupants ample time or opportunity to escape to safe ground.

- Most flood proofing techniques should be formulated and designed by experienced personnel (engineers or contractors) to ensure adequate consideration of all factors that could affect the techniques' effectiveness.
- Flood proofing techniques cannot be installed and forgotten. Maintenance must be performed on a scheduled basis to ensure that the flood proofing techniques adequately protect the structures over time.
- Floods may exceed the level of protection provided. Therefore, when any of the flood proofing techniques are chosen, considerations should be given to, purchasing flood insurance as well as securing the property and vacating the premises during flood events.

Advantages

Where flood proofing is appropriate, it has several advantages over other ways of reducing flood damages. Flood proofing can be undertaken by individual property owners without waiting for government action and it can provide protection in areas where large structural projects, such as construction of dams or major waterway improvements, are not warranted.

CHAPTER 2

GOVERNMENT FLOOD PROOFING PROGRAMS

Local, state, and federal government agencies perform a variety of activities that implement or support flood proofing. This chapter groups the activities into six categories. These categories are used in the next chapter and in the matrix on page 20 to explain the programs of specific agencies.

• General Information

The most common way government agencies support flood proofing is by providing publications and general information to interested property owners. Several federal and state agencies have published manuals on the topic that are available to individuals and to state and local governments for free distribution. Some of the publications are listed in Chapter 4.

Many local governments have prepared their own brochures that address local flooding and building conditions. Often these are distributed free to all residents of the floodplain or, particularly in the case of basement flooding, to all residents of the community. These federal, state, and local publications usually discuss flood proofing in general terms and provide property owners with an idea of what techniques would work for their situation.

Agencies also answer general questions about flood proofing and related topics. Local building, housing, and community development departments refer callers to the publications or state and federal agencies that provide assistance. Some maintain lists of flood proofing contractors or consultants.

• Technical Assistance

While many agencies provide general information, a few provide more specific information to advise property owners about flood proofing individual buildings. This can include a range of services such as providing flood and building elevations, discussing options for protecting a building, recommending specific techniques, and reviewing the owner's building plans.

Several agencies have developed "flood audit" programs. These include a site visit, discussions with the owner, and a written report that recommends specific flood proofing and other preparedness steps, such as purchasing flood insurance. Flood audits have been conducted for residences as well as commercial or industrial complexes.

Technical assistance is specific and usually provides more help to a property owner than general information such as that found in a brochure or other publication. However, few governmental agencies provide technical assistance for individual buildings due to the staff time necessary. In addition, "free" technical assistance service may not include careful examination of a building's structural condition, tests of wall strength, etc. Governmental agencies are hesitant to make specific recommendations based on what can only be a relatively cursory inspection.

• Regulations

Most regulations for flood proofing are based on the minimum standards of the National Flood Insurance Program (NFIP -- See *FEMA*, page 9). The NFIP sets minimum regulatory standards for constructing, modifying, or repairing buildings located in the floodplain to keep flood losses to a minimum. Over 19,000 flood-prone communities have adopted and enforce the minimum standards and many have more restrictive requirements. The NFIP limits some flood proofing; it prohibits obstructions, such as berms and floodwalls, in floodways.* Enclosing the area under an elevated building is not allowed in coastal high hazard areas. *

The NFIP also requires structure specific flood proofing for a building not in the floodway that is substantially improved or substantially damaged. "Substantially damaged" is defined as "damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred." Houses that have been substantially damaged or are being substantially improved (renovated) must be elevated to or above the 100-year flood level (see *FEMA*, page 9). Non-residential buildings must be elevated or dry flood proofed.

Many states and communities have more restrictive standards than the NFIP. The most common is freeboard, requiring an extra margin of safety in the design and construction of flood protection measures to account for waves, debris, hydraulic surge, or lack of flooding data. Some prohibit buildings or residences in certain areas, such as a floodplain or conservation zone. In these communities, substantially damaged buildings would not be allowed to be rebuilt unless they are relocated.

● Financial Assistance

The homeowners' decisions to flood proof and the type of flood proofing systems they choose are directly related to their financial condition. This is very evident after a flood when the need for flood proofing is more pronounced and when the homeowners' interest levels are high, but also when they are in a difficult financial position. In many cases, availability of financial assistance makes the difference as to whether a property will be flood proofed.

Financial assistance can come in a variety of forms. For example, local governments could use property tax incentives to encourage flood proofing. Most financial assistance programs provide low interest loans and grants. Generally, grants are limited to lower income families.

There are several Federal, State, and local financial assistance programs (*see Chapter 3*) for which flood proofing is a secondary objective. Usually, the owner must show that flood proofing is related to the program's primary concerns of rebuilding after a disaster, improving housing, or preserving or increasing employment opportunities.

● Projects

The greatest degree of government involvement is in the construction of public flood proofing projects. The agency would prepare the construction plans, get the owner's agreement, hire the contractor, and inspect the work. The more common projects include public buildings, such as schools and waterfront park buildings.

There are a few examples of government-built flood proofing projects on private property. Some of these start as financial assistance programs, but evolve into projects because the homeowners are unable to handle the technical aspects of managing a construction project. Others begin when flood control project plans find that flood proofing is the most cost effective approach to reduce flood damages.

● Research and Technology Transfer

Several Federal and some state agencies have conducted or sponsored research into flood proofing materials and techniques as well as ways to assist property owners with flood proofing. The largest research program is under the direction of the U.S. Army Corps of Engineers' National Flood Proofing Committee, which has conducted studies and tests of: ability of structure walls to withstand flooding; waterproofing compounds and materials; raising and moving structures, including slab-on-grade houses; and other miscellaneous flood proofing systems and techniques, including the use of a flexible, waterproof membrane to "wrap" a house. Other agencies have investigated flood proofing techniques, ways to motivate owners, alternative financial assistance arrangements, and techniques for disseminating technical information.

There have been a few training programs, most of them for disaster assistance workers or local officials who implement State or Federal technical or financial assistance programs. Some agencies hold or sponsor public meetings or workshops for property owners.

CHAPTER 3 FLOOD PROOFING PROGRAMS

This chapter reviews the flood proofing programs conducted by five Federal agencies. Programs that are usually undertaken by State and local agencies are also covered. The matrix at the bottom of page 20 relates these agencies to the government flood proofing activities discussed in Chapter 2.

• U.S. Army Corps of Engineers (COE)

The U.S. Army Corps of Engineers is the nation's oldest and largest water resources agency. Through its civil works programs, the Corps conducts feasibility studies and builds flood damage reduction projects. Where it is shown to be cost-effective, these projects can include flood proofing. Major projects require specific authorization and funding by Congress, while small projects can be implemented with agency authority.

The Corps Flood Plain Management Services Program provides flood hazard determinations, technical data on flood hazards, and guidance on flood proofing, flood plain regulations, flood warning, emergency preparedness, and evacuation planning. It also staffs the National Flood Proofing Committee, which supervises research and provides technology transfer on relocation, elevation, and other types of flood proofing techniques. The Committee also conducts community workshops, develops and disseminates publications, coordinates with other agencies and associations involved in flood proofing, as well as complete nonstructural damage reduction projects.

Point of Contact: The Corps' civil works programs are organized in divisions and districts that cover the entire country (*see map on page 21*). The main point of contact is the Flood Plain Management Services (FPMS) coordinator. Corps' offices are listed on pages 22 and 23.

• Federal Emergency Management Agency (FEMA)

Disaster Assistance - The Federal Emergency Management Agency was created to coordinate the Federal Government's response to disasters. FEMA's disaster assistance programs make funds available following a declaration of a major disaster by the President. Damaged public facilities are eligible for grants at a cost share, of at least 75 % Federal and 25 % State funds, for repairs and cost-effective flood proofing and other mitigation measures under Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (as amended). Section 404 of the "Act" was recently amended to provide increased funds to states and communities to fund 75 % of the cost of post-disaster mitigation projects. The projects may include providing technical and financial assistance to property owners to permanently mitigate flood hazards. The projects may include providing technical and financial assistance to property owners to permanently mitigate flood hazards. Mitigation activities in FEMA are primarily the responsibilities of the Agency's Mitigation Directorate.

The National Flood Insurance Program - The Federal Insurance Administration (FIA) is the part of FEMA that administers the insurance provisions of the National Flood Insurance Program (NFIP), while the Mitigation Directorate administers the flood plain management provisions of the NFIP. The FIA manages the Flood Insurance Fund, conducts marketing campaigns to promote the purchase of insurance, sets flood insurance rates, and ensures that companies selling NFIP insurance comply with the program's requirements. The Mitigation Directorate provides technical assistance and guidance, flood hazard mapping, and develops flood plain management regulations. Areas that are prone to flooding from the occurrence of a 100-year flood are shown on each community's Flood Insurance Rate Map (FIRM). The Mitigation Directorate also conducts research, public information, and technology transfer activities to improve flood proofing and other mitigation.

In accordance with the National Flood Insurance Reform Act of 1994, Increased Cost of Compliance (ICC) coverage is provided on all new or renewed regular program flood insurance policies on or before June 1, 1996, except buildings insured under the Group Flood Insurance Policy or insured under a condominium unit owner policy. Emergency Program policies are also excluded from ICC Coverage. ICC coverage provides for the payment of a claim up to the maximum dollar amount stated in the policy to bring buildings into compliance with State or community flood plain management laws or ordinances after flood losses for substantially or repetitively damaged buildings. ICC provides for the increased costs to elevate, flood proof, demolish, or relocate the building. Policy holders should review their contract for flood insurance or contact their agent for more information on ICC coverage.

Also under the National Flood Insurance Reform Act of 1994, the Flood Mitigation Assistance (FMA) Program authorizes FEMA to provide financial assistance to States and communities for planning assistance and for mitigation projects. The overall goal of the FMA is to fund cost-effective measures that reduce or eliminate the long-term risk of flood damage to insured buildings.

Point of contact: FEMA's work is conducted through ten regional offices as shown on page 25.

- **Natural Resources Conservation Service (NRCS)**

As part of the U.S. Department of Agriculture, the NRCS (formerly the Soil Conservation Service) primarily serves rural areas. NRCS staff provides information on land use planning, conservation planning, resource development, water management and flood prevention to farmers, community officials, and land developers. While mostly a general information and technical assistance operation, NRCS also funds flood protection projects that can include flood proofing elements.

Point of contact: The NRCS work is conducted through local soil and water conservation districts. The point of contact is the district conservationist who usually has an office in the county seat (*check the local telephone directory*).

- **Small Business Administration (SBA)**

The SBA administers the federal government's major disaster loan program. In spite of its name, SBA disaster loans are available for any privately owned property, including businesses and residences. The low interest loans are provided to rebuild a damaged building, including the cost of bringing a building up to the building code standards. The loans can pay for code-required flood proofing of substantially damaged buildings and some smaller projects that are not required by code.

Point of contact: SBA disaster related loans are only available following either an SBA or Presidentially declared disaster. Disaster Application Centers are established to process applications. The location and hours of these centers are well publicized.

- **Department of Housing and Urban Development (HUD)**

HUD programs are designed to improve housing conditions, local economies, and neighborhoods. As the nation's housing agency, HUD has been active in protecting both public and privately owned houses from flood damage. HUD's major flood proofing program is the Community Development Block Grant (CDBG), which provides funds directly to larger cities and counties. States handle CDBG funds for smaller communities.

The block grant concept allows states and communities to set their funding priorities as long as the local projects relate to program objectives, i.e., they must benefit low and moderate income people, prevent or eliminate slums and blight, or meet other urgent community development needs. Many communities have used CDBG funds to flood proof buildings as a way to provide low-income residents with safe and sanitary housing. Some states have reserved block grant funds for special post-disaster projects that have included flood proofing.

Point of contact: Each state has a HUD Area Office, located in its capital or largest city. State departments of community affairs are also points of contact on the Community Development Block Grant (*check the local telephone directory*).

- **Association of State Flood Plain Managers (ASFPM)**

While not a government agency, the ASFPM supports many government flood proofing programs. Its Floodproofing/Retrofitting committee works on coordinating and publicizing federal, state, and local flood proofing activities. Its Mitigation Committee focuses on post-disaster activities, especially programs that can provide funding help to property owners.

The Association is a provider of general information and has published several reports on flood proofing activities. Its conferences are the largest in the nation on flood plain management and usually include one or more sessions on flood proofing. The Association is also a good source of information on state and local floodplain management programs and contacts.

Point of contact: Executive Director
Association of State Flood Plain Managers
2809 Fish Hatchery Road, Suite 204
Madison, WI 53713
608/ 274-0123

- **State Housing and Community Affairs Agencies**

Most states have a department of community affairs or similar office that is responsible for managing the Community Development Block Grant (*see HUD*). Some states have their own funding programs that operate similar to the Block Grant. They fund housing or economic improvement projects, including protecting buildings from floods. Some agencies provide technical assistance to communities undertaking flood plain management planning or establishing programs to help property owners.

Point of contact: The title and duties will vary from state to state, but most will have a community affairs agency located in the state capital.

- **State Flood Plain Management Coordinators**

Most states have a flood plain management coordinator whose duties include advising and assisting local officials and property owners about the National Flood Insurance Program (NFIP), particularly its regulatory aspects. These offices are also the best sources of information about related flood plain management issues, including programs that affect or support flood proofing. A few state coordinating offices provide technical assistance or manage financial assistance programs.

Point of contact: State coordinators can be located by contacting the appropriate FEMA Regional Office (*see page 25*) or the Association of State Flood Plain Managers (*see above*).

- **Local Building Departments**

Regulations that affect flood proofing are implemented by local building, zoning, or housing code departments. These offices sometimes provide general information and technical assistance to property owners. Several have developed handbooks on flood proofing for their residents.

Point of contact: Generally, county regulatory departments only operate unincorporated areas. Municipal departments have jurisdiction in incorporated cities, towns, and villages (*check the local telephone directory*). State NFIP coordinators and FEMA Regional Offices may know of local departments particularly active in flood proofing.

- **Local Housing, Community Development, and Planning Agencies**

There are many different kinds of city, county, and regional agencies involved in housing, planning, urban renewal, and community development. Community development departments and housing authorities work to improve local housing conditions through public housing and other programs to help low and moderate income residents. This work can be in the form of building inspections, technical assistance, and financial assistance.

Other local and regional agencies include regional planning commissions, sanitary districts, and water management districts. Most provide general information to residents and technical assistance to local officials. Some sanitary districts have regulatory authority based on the need to keep floodgates out of sewer lines. Some of these agencies have active technical and financial assistance programs to help property owners flood proof.

Point of contact: These agencies may be listed in the local telephone directory. State NFIP coordinators and FEMA Regional Offices may know of agencies particularly active in flood proofing.

CHAPTER 4

RECOMMENDED FLOOD PROOFING REFERENCES

This chapter describes recommended flood proofing references. People interested in more detailed and specific information on this subject are encouraged to obtain copies of these publications. They are recommended because they cover most of the important aspects of flood proofing (see the matrix at the top of page 20 for contents of the publications). The publications are listed below by agency source.

The next chapter discusses how to obtain more publications on flood proofing. State flood plain management coordinators usually know of additional publications that may be available from state and local offices.

Order the following publications from:

**U.S. Army Corps of Engineers
Attn: CECW-PF
20 Massachusetts Avenue, NW
Washington, D.C. 20314**

All of the COE's publications are available online and can be downloaded over the Internet. For more information go to: www.usace.army.mil/inet/functions/cw/cecwp/nfpc.htm

● **Flood Proofing Performance, Successes and Failures**

U.S. Army Corps of Engineers, 1998, 116 pages. The publication documents how flood proofing measures have performed when tested by floodwaters. The information in the publication was acquired by using 12 selected flood areas across the United States during the 1986-1997 timeframe. Flood proofed structures located within those flooded areas were inspected to determine the performance of different flood proofing measures. The publication includes "lessons" on what worked and what did not. Includes over 50 color photographs.

● **Flood Proofing Regulations**

U.S. Army Corps of Engineers, published in 1972, updated and rewritten in 1992, and revised for minor corrections in 1995, 48 pages. The definitive work by the Corps of Engineers that provides construction specifications for flood proofing new buildings. It includes detailed lists of materials for areas to be wet flood proofed. The manual is organized to facilitate easy adoption by reference to a building code and provides both technical data and guidelines for ordinance administration. Illustrated with line drawings.

● **Local Flood Proofing Programs**

U.S. Army Corps of Engineers, 1994, 28 pages. This publication is intended to assist local communities in developing their own flood proofing programs. It identifies the factors that communities should consider in establishing flood proofing programs, overviews case studies of existing programs, and contains examples of pertinent documents used by various communities in developing their programs.

● **Flood Proofing Technology in the Tug Fork Valley**

U.S. Army Corps of Engineers, 1994, 20 pages. Important technical and administrative lessons learned are documented in this publication for flood proofing structures located in Williamson and Matewan, West Virginia and South Williamson, Kentucky, as part of the flood damage reduction plan for the Tug Fork River Basin. It also contains an excellent display of how residential structures look after they have been raised for flood proofing, a primary concern of homeowners.

- **Flood Proofing: How to Evaluate Your Options**

U.S. Army Corps of Engineers, 1993, 32 pages. This publication is intended to assist property owners, engineers, and contractors in determining whether or not flood proofing is appropriate and which flood proofing technique is the best measure to consider. A detailed explanation is contained on how to evaluate flood proofing options and how to conduct a benefit/cost analysis.

- **A Flood Proofing Success Story along Dry Creek at Goodlettsville, Tennessee**

U.S. Army Corps of Engineers, 1993, 17 pages. An innovative publication that documents the procedures used to reduce the costs of a flood damage reduction project along Dry Creek at Goodlettsville, Tennessee. The appendices contain samples of documents used in the project and an equation that can be used by others to quickly estimate the approximate costs of flood proofing selected homes by raising them in place. The cost-estimating equation, however, is applicable only to one-story, brick veneer homes with crawl spaces and in sound structural condition.

- **Raising and Moving the Slab-on-Grade House with Slab Attached**

U.S. Army Corps of Engineers, 1990, 28 pages. This report discusses the procedures for raising or relocating "slab-on-grade" structures with the slab attached. It points out advantages and disadvantages, suggests factors to consider, and indicates possible costs involved. The procedures and techniques described are based primarily on those employed by a professional structural mover operating in the Tampa, Florida area.

- **Flood Proofing Tests - Tests of Materials and Systems for Flood Proofing Structures**

U.S. Army Corps of Engineers, 1988, 89 pages. This report presents test results which describe materials and systems that can be used to protect buildings from floodgates. Closures, materials, and systems were tested to determine the effectiveness in protecting homes or businesses from floodgates, with conclusions provided for each test.

- **Flood Proofing Systems & Techniques - Examples of Flood Proofed Structures in the United States**

U.S. Army Corps of Engineers, 1984, 100 pages. An illustrated, easy-to-read review of 40 different buildings that have been elevated, dry and wet flood proofed, leveed, or otherwise protected. Buildings include new construction and flood proofed houses, businesses, schools, office buildings, and factories. Narratives include costs. Many examples include photos of flooding.

Order the following publications/bulletins from:

**Federal Emergency Management Agency
Attn: Publications
P.O. Box 2012
Jessup, MD 20794-2012
or dial: 1-800-480-2520**

Many of FEMA's publications are available online and can be downloaded over the Internet. For more information go to: www.fema.gov

- **Protecting Building Utilities from Flood Damage**

Federal Emergency Management Agency, 2000, 192 pages (FEMA 348). The intended users of this manual are developers, architects, engineers, building code officials and homeowners who are involved in designing and constructing building utility systems for residential and non-residential structures. The manual discusses flood protective design and construction of utility systems for new buildings and modifications to utility systems in existing buildings.

- **Above the Flood: Elevating Your Flood Prone House**

Federal Emergency Management Agency, 2000, 60 pages (FEMA 347). This publication describes how homeowners in the Miami-Dade County area of Florida elevated their damaged slab-on-grade masonry houses following the devastating effects of Hurricane Andrew. It looks at three common techniques appropriate for a variety of houses on different types of foundations and summarizes the benefits of elevating a flood prone house. FEMA 347 is available on CD.

- **Coastal Construction Manual**

Federal Emergency Management Agency, 2000, (FEMA 55 III ed.). This manual provides guidance for the design and construction of coastal residential buildings that will be more resistant to the damaging effects of natural hazards. Discussions, examples, and example problems are provided for buildings located in or near coastal flood hazard areas. The manual highlights the many tasks and decisions that must be made before actual construction begins. It also identifies the best design and construction practices that can be used to build disaster-resistant structures. This manual will also be available on CD.

- **Building Performance Assessment: Hurricane Georges in Puerto Rico**

Federal Emergency Management Agency, 1999, 108 pages (FEMA 339). On September 21, 1998, Hurricane Georges made landfall on Puerto Rico as a strong Category 2 hurricane. As a result, FEMA deployed a building performance assessment team to assess the performance of buildings and other structures throughout Puerto Rico and make recommendation for improving building performance in future events. Available online at: www.fema.gov/mit/bpat/prfinal.htm

- **Building Performance Assessment: Hurricane Georges in the Gulf Coast**

Federal Emergency Management Agency, 1999, 102 pages (FEMA 338). On September 28, 1998, Hurricane Georges made landfall in the Ocean Springs/Biloxi, Mississippi, area. The storm moved slowly north and east, causing heavy damage along the Gulf Coast in Alabama, Florida, and Mississippi. The building performance assessment team assessed the damages and also evaluated the success and effectiveness of flood and wind hazard mitigation initiatives undertaken prior to Hurricane Georges. Available online at: www.fema.gov/mit/bpat/rptfinal.htm

- **Homeowners' Guide to Retrofitting: Six Ways to Protect Your House from Flooding**

Federal Emergency Management Agency, 1998, 177 pages (FEMA 312). FEMA prepared this guide specifically for homeowners who want to know how to protect their houses from flooding. It presents clear information about available options and straightforward guidance to help in decision making. It's designed for readers with little or no knowledge about flood protection methods or building construction techniques. Available online at: www.fema.gov/mit/rfit/.

- **Building Performance Assessment: Hurricane Fran in North Carolina**

Federal Emergency Management Agency, 1997, (FEMA 290). On September 5, 1996, Hurricane Fran made landfall near Cape Fear. Coastal areas experienced significant erosion and scour. The building performance assessment team produced this report containing their observations, recommendations, and technical guidance.

- **Hurricane Opal in Florida, A Building Performance Assessment**

Federal Emergency Management Agency, 1996, 41 pages (FEMA 281). On October 4, 1995, Hurricane Opal made landfall on Santa Rosa Island. The resulting damage from the Category 3 storm led to (15) Florida panhandle counties being declared Federal disaster areas. The building performance assessment team produced this report to evaluate the structural damage and recommend mitigation measures to enhance the performance of buildings in future storms.

- **Engineering Principals and Practices for Retrofitting Flood Prone Residential Buildings**

Federal Emergency Management Agency, 1995, over 900 pages (FEMA-259). A well-detailed manual for engineers, architects, and building officials on the engineering considerations in retrofitting flood prone residential buildings. The complete process of evaluating structures, hazard identification, homeowner's preferences, economic analysis, alternative selection, and finally design criteria are extensively discussed. Numerous case studies are provided as well. A software computer model is provided with the manual.

- **Mitigation of Flood and Erosion Damage to Residential Buildings in Coastal Areas**

Federal Emergency Management Agency, 1994, 36 pages (FEMA-257). An extensive review of the different flood proofing alternatives available to mitigate against flood and erosion damage in coastal areas. Eleven state projects are covered in the second half of the publication.

- **Building Performance: Hurricane Iniki in Hawaii**

Federal Emergency Management Agency, 1993, 100 pages (FIA-23). On September 11, 1992, Hurricane Iniki struck the Island of Kauai, generating high winds and storm surge over a vast area of the island, causing extensive damage. The building performance assessment team was deployed to survey the damages to building systems, diagnose characteristic modes of building system failures, identify successful building systems, and offer recommendations and guidance on reducing similar damage in the future.

- **Building Performance: Hurricane Andres in Florida**

Federal Emergency Management Agency, 1993, 93 pages (FIA-22). On August 24, 1992, Hurricane Andrew struck southern Dade County, generating high winds, rain, and storm surge, which caused extensive damage. This report presents the findings of the building performance assessment team. The team surveyed the performance of residential building systems in the storm's path. The report contains recommendations on reducing future hurricane damage by focusing on areas of concern, such as building materials, construction techniques, code compliance, quality of construction, plan review, inspection, and reconstruction/retrofit efforts.

- **Repairing Your Flooded Home**

Federal Emergency Management Agency, 1992, 60 pages (FEMA-234). A well-illustrated manual for property owners on emergency flood proofing, cleanup, and repair. It covers how floods damage buildings and what the owner can do to minimize damage. The thrust of the manual is on emergency actions and cleanup. Many technical topics are explained in lay terms. An excellent document to distribute to people threatened with an impending flood or who have just been flooded. Spanish version also available.

- **Flood Proofing Non-Residential Structures**

Federal Emergency Management Agency, 1986, 200 pages (FEMA-102). An overview of flood proofing new and existing buildings designed to familiarize the reader with a variety of techniques. Flood proofing is divided into two parts: permanent (elevation, dry flood proofing, and levees and flood walls) and emergency and wet flood proofing. There are many drawings and photos to illustrate key points. Selection processes, case studies, sources of assistance, and performance criteria are also covered.

- **Manufactured Home Installation in Flood Hazard Areas**

Federal Emergency Management Agency, 1985, 100 pages (FEMA-85). This is a comprehensive review of how to elevate and anchor a mobile or manufactured home to protect it from flood and wind damage. The book has numerous drawings and photographs. It covers mobile home construction practices, regulatory standards, susceptibility to damage from wind and floods, and how to install a manufactured home on an elevated foundation. Included are standards for builders and technical formulas for engineers.

- **Elevated Residential Structures**

Federal Emergency Management Agency, 1984, 135 pages (FEMA 54). A review of how to build an elevated building. Concepts, examples, and performance criteria are given, but technical specifications are not. Numerous examples are discussed with architectural drawings and photographs. Cost analyses are covered and calculation forms are included. Sources of information and assistance are listed.

- **Homeowners' Guide to Retrofitting (Brochure)**

Federal Emergency Management Agency Brochure (FEMA L235). Introduces FEMA 312 and briefly describes "retrofitting," next steps, and financial assistance. Available online at: www.fema.gov/mit/rfit/L-235.pdf.

- **Technical Bulletins: User's Guide with Key Word and Subject Index**

Federal Emergency Management Agency/Federal Insurance Agency, 6 pages. Provides a list of the following seven technical bulletins, a key word/subject reference index for all the bulletins, and information about how to obtain copies of the bulletins. All technical bulletins available online at: www.fema.gov/mit/techbul.htm.

- **Technical Bulletin 1: Openings in Foundation Walls**

Federal Emergency Management Agency/Federal Insurance Agency, 12 pages. Guidance on the NFIP regulations concerning the requirement for openings in below Base Flood Elevation foundation walls for buildings located in Zones A, AE, A1-A30, AR, AO, and AH.

- **Technical Bulletin 2: Flood-Resistant Materials Requirements**

Federal Emergency Management Agency/Federal Insurance Agency, 16 pages. Guidance on the NFIP regulations concerning the required use of flood damage-resistant construction materials for building components located below the Base Flood Elevation in special flood hazard areas (both A and V Zones).

- **Technical Bulletin 3: Non-Residential Flood Proofing - Requirements and Certification**

Federal Emergency Management Agency/Federal Insurance Agency, 15 pages. Guidance on the NFIP regulations concerning watertight construction and the required certification for flood proofed non-residential buildings in Zones A, AE, A1-A30, AR, AO, and AH, whose lowest floors are below the Base Flood Elevation.

- **Technical Bulletin 4: Elevator Installation**

Federal Emergency Management Agency/Federal Insurance Agency, 6 pages. Guidance on the NFIP regulations concerning the installation of elevators below the Base Flood Elevation in special flood hazard areas (both A and V Zones).

- **Technical Bulletin 5: Free-of-Obstruction Requirements**

Federal Emergency Management Agency/Federal Insurance Agency, 9 pages. Guidance on the NFIP regulations concerning obstruction to floodgates below elevated buildings and on building sites in coastal high hazard areas (Zones V, VE, and V1-V30).

- **Technical Bulletin 6: Below-Grade Parking Requirements**

Federal Emergency Management Agency/Federal Insurance Agency, 6 pages. Guidance on the NFIP regulations concerning the design of below-grade parking garages beneath buildings located in Zones A, AE, A1-A30, AR, AO, and AH.

- **Technical Bulletin 7: Wet Flood Proofing Requirements**

Federal Emergency Management Agency/Federal Insurance Agency, 19 pages. Guidance on the NFIP regulations concerning the design of wet flood proofing for non-residential structures. Note: FEMA does not recognize wet flood proofing of residential homes.

- **Technical Bulletin 8: Corrosion Protection for Metal Connectors in Coastal Areas**

Federal Emergency Management Agency/Federal Insurance Agency, 12 pages. Guidance on the NFIP regulations concerning the resistance of buildings to flood and wind forces in coastal high hazard areas.

- **Technical Bulletin 9: Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings**

Federal Emergency Management Agency/Federal Insurance Agency, 15 pages. This bulletin describes prescriptive design details that comply with the breakaway wall requirements of the NFIP regulations for elevated coastal buildings.

Order the following publications from:

**Association of State Flood Plain Managers
Attn: Publications
2809 Fish Hatchery Road, Suite 204
Madison, WI 53713
608/ 274-0123**

- **Flood Plain Management: State and Local Programs**

Association of State Flood Plain Managers, about 100 pages. This publication discusses what the states are doing in flood plain management. There are numerous tables that identify what is being done by all 50 states and the District of Columbia, including state flood proofing activities. Each state's programs and selected local programs are reviewed. Note: revised versions of the document are published every three years.

- **National Directory of Flood Plain Managers**

Association of State Flood Plain Managers, about 150 pages. A directory of all members of the Association that includes sections on Federal agencies (including summaries of their programs), publications, committee progress reports, and cross references of members by area of interest and state. This is the only national directory of State Flood Plain Management staff. Note: revised versions of this document are published annually.

CHAPTER 5

THE FLOODPLAIN MANAGEMENT RESOURCE CENTER

Chapter 4 introduced 27 reports and 9 technical bulletins that provide a basic understanding on flood proofing. There are many more publications on various aspects of flood proofing. Most of them have been collected and cataloged at the Floodplain Management Resource Center. The Floodplain Management Resource Center is located at the Natural Hazards Center in Boulder, Colorado. It houses the nation's largest collection of documents on flood proofing. This chapter explains how to locate these additional publications.

Any person may use the Resource Center. It is a public service established by the Association of State Flood Plain Managers with financial support from the Corps of Engineers, the Federal Emergency Management Agency, the Environmental Protection Agency, and other public and private organizations.

• Operation

Each document has been categorized and summarized. The summaries have been entered into a computer data base that enables Center staff to quickly identify those documents most appropriate for an inquirer's needs.

A person may contact the Center by calling 303/492-6818 between 9:00 and 4:00 Mountain Time, Monday through Friday, or by writing to the Natural Hazards Center, Campus Box 482, Boulder, Colorado, 80309-0482. Upon receiving an inquiry, a Center staff person will review the data base and retrieve summaries of those documents that appear most useful.

The Center staff person may read excerpts from the document summaries over the telephone or mail printed document summaries to the inquirer. The Resource Center does not send a document to the inquirer; it only tells the inquirer how to obtain a copy. The staff may copy all or portions of a document that are in the public domain (especially those that are out of print).

The cost of answering inquiries, including printing and mailing up to ten document summaries, is borne by the Resource Center. There is no cost for these services to any caller. The Center may charge a fee for copying a document or providing additional services. The fee is based on the actual cost of duplicating or performing the service.

• Document Summaries

All records on the Center's flood proofing publications are kept on document summaries. The summaries follow the adjacent format. This format provides all necessary data about a document on one page so the Center staff and the inquirer can quickly and easily identify if the document is appropriate. While no document takes more than one page, a different summary page may be used for each article in publications such as conference proceedings and edited collections of articles by different authors on different topics.

Floodplain Management Resource Center Document Summary Format	
Heading	Meaning...
<i>FRCNo</i>	<i>Floodplain Resource Center Number</i>
<i>LCNo</i>	<i>Library of Congress Number</i>
<i>SuDocNo</i>	<i>Superintendent of Documents Number used for documents published by the U.S. Government Printing Office</i>
<i>ISBN</i>	<i>International Standard Book Number</i>
<i>Title</i>	
<i>Descript</i>	<i>A one-sentence description of the document</i>
<i>Author</i>	
<i>Pub Year</i>	<i>Year of Publication</i>
<i>Topic</i>	<i>Topic keywords</i>
<i>Focus</i>	<i>Focus keywords</i>
<i>Audience</i>	<i>Audience keywords</i>
<i>Summary</i>	<i>A one- or two-paragraph narrative overview of the document</i>
<i>Contents</i>	<i>The table of contents</i>
<i>Price</i>	
<i>Order</i>	<i>How to order a copy from the author or agency</i>

Floodplain Management Resource Center

KEYWORDS

Topic Keywords

FLOOD PROOFING

Acquisition
Relocation
Elevation
Dry flood proofing
Pressures
Waterproofing
Closure
Sewer
Basement
Wet flood proofing
Utility protection

Material

Facilities

Behavior

Focus Keywords

Advertising
Bibliography
Examples
Government Programs
Publicity
Research
Techniques
Training

Audience Keywords

Appraisers
Architects
Attorneys
Builders
Code Enforcers

Community Groups
Educators
Engineers
Federal Officials
Lay Persons
Lenders
Local Officials
Naturalists
Planners
Realtors
State Officials

Includes...

Demolition

Raising a building
Keeping water out of a building
Hydrostatic, hydrodynamic, uplift
Sealants

Sewer backup protection

Letting water into a building
Protection of water, electrical,
gas, heating, air conditioning
and other utilities

Construction materials and contents
appropriate for wet flood proofed areas
Protection of facilities other than
buildings (e.g. roads, bridges, parks
treatment plants)

Attitudes and perceptions of residents;
projects to encourage flood proofing

Brochures, etc. on company products

Case studies
Funding, rules, and regulations
Public information, handouts, brochures

Methods, "how-to"

Tax assessors, insurance adjusters

Building contractors
Zoning administrators, building
officials, boards of appeals or adjustment

Non-governmental, neighborhood associations
Teachers
Surveyors

Property owners, homeowners
Bankers, mortgage companies

Environmentalists, biologists, botanists
Planning Commissioners

• Keywords

The Resource Center's computer program can search for any word. Three sections of the document summary list selected keywords that help the Center and the inquirer locate the documents they need. The Topic Keywords identify the floodplain management activity. The Focus Keywords explain how the topic is addressed and the Audience Keywords list the type of reader the publication is directed to.

Using the keywords can greatly assist in the document search. For example, a request for a book on flood proofing basements will yield more than 25 publications. In most cases, the inquirer has a more specific interest. For example, if a caller wants a book that explains protecting basements from hydrostatic pressure to homeowners, the Center staff's search would be:

Topic = "pressures" and basement"
Focus = "techniques"
Audience = "lay persons"

This particular search will locate two books (more will probably be added over time). The inquirer will be told about the books and how to obtain them and will also be sent the document summaries.

CHAPTER 6

GLOSSARY

There are often local variations in the use of these terms, especially those related to building construction.

Anchoring: Methods used to secure a structure to the ground so it will not be moved by hydrodynamic forces, uplift, or wind.

Berm: A mound of earth, located either away from a building, as a levee, or against the building wall.

Building code: Regulations adopted by a state or local government that set minimum standards for constructing, improving, or rebuilding a building or other structure.

Closure: A waterproof shield of metal or wood used to cover doorways and windows or to fill gaps left in floodwalls, levees, and berms.

Coastal high hazard flooding: A condition of flooding subject to high velocity waters, including, but not limited to, hurricane wave wash or tsunamis.

Column (or post): A vertical support member of a building that is set in a hole. Columns are made of wood, steel, or precast concrete and are normally anchored into a concrete pad at the bottom of the hole. They are frequently used in retrofitting.

Crawl space: The area under the first floor used for utilities. Buildings on slab or basement foundations do not have crawl spaces.

Dry flood proofing: Flood proofing measures designed to keep water from entering a building.

Elevation: Raising a building and placing it on a higher foundation so the first or lowest floor is above flood levels.

Erosion: The wearing away of the land surface by detachment and movement of soil and rock fragments through the action of moving water and other geological agents.

Flood crest: The maximum level or elevation reached by water during a flood.

Flood fighting: Actions taken immediately before or during a flood to protect people and property, such as sandbagging and rescue operations.

Floodplain: The relatively flat area or lowlands adjoining a river, stream, ocean, lake, or other body of water that is susceptible to being inundated by floodwaters.

Flood proofing: Any combination of structural or non-structural changes or adjustments incorporated in the design, construction, or alteration of individual buildings or properties that will reduce flood damages.

Flood Protection Level: The level or elevation of floodwaters to which a structure or its contents are protected from flooding.

Floodwall: A barrier of concrete, masonry block, or other impervious material designed to keep water away from a building.

Floodway: The channel of a river and the portion of the adjacent overbank floodplain that usually carry most of a flood. The floodway must be kept open so that floods can proceed downstream and not be obstructed or diverted onto other properties. The NFIP and local regulations prohibit construction in floodways that obstructs flood flows and increases flood heights.

Freeboard: An extra margin of safety added to the base flood elevation to account for waves, debris, hydraulic surge, or lack of data.

Head: How high water is above a specific elevation. Head is used to determine hydrostatic loads.

Housing code: Regulations adopted by a state or local government that set minimum standards for maintenance and upkeep of buildings.

Human intervention: Flood proofing activities that require people involvement to be effective. Putting a closure in place after a flood warning is issued is an example of human intervention.

Hydrodynamic forces: Loads placed on a building by moving water, including waves, ice, and debris. Hydrodynamic forces can move a building, knock it over, batter its walls, and scour supporting fill.

Hydrostatic pressure: The pressure that is put on a building by standing water. It is measured in pounds per square foot. Hydrostatic pressure increases as water gets deeper. Standing water acts on building walls (lateral pressure) and floors (uplift).

100-year flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the base or one percent chance flood. The 100-year flood is a statistical concept used to measure the risk of flooding and is used as the flood protection level for the National Flood Insurance Program (NFIP).

Pier: Vertical structural member of a building that is supported by reinforced concrete footings. While they may be the most representative type of foundation, they are the least suited for withstanding flood forces.

Pile or piling: A vertical support member of a building that is driven into the ground. They are best for areas where high velocity flooding can result in scouring around the foundation.

Relocation: Moving a building or its contents to a flood-free location.

Retrofitting: Modifying an existing building, often used interchangeably with flood proofing.

Scour: Removal of the river bed by flowing water.

Slab: A foundation with the first floor of poured concrete that sits directly on the ground. Also called "slab on grade."

Substantial Improvement: Any reconstruction, rehabilitation, addition, or other improvement of a building, the cost of which equals or exceeds 50% of the market value of the building before the start of construction of the improvement. This term includes repairs to buildings that have incurred substantial damage, regardless of the actual repair work performed.

Subsurface drainage system: A system that has perforated drain pipes underground, usually next to the foundation footings. Ground water and underseepage enter the pipe and flow to a well or sump. The sump water is pumped out on the top of the ground or into a storm sewer system.

Sump pump: A pump that removes water from a subsurface drainage system.

Tsunami: A very large ocean wave produced by an undersea earthquake or volcano disturbance.

Underseepage: The passage of water through the ground under a levee, berm, floodwall, or watertight building walls. Depending on the permeability of the soil and the duration of a flood, underseepage can negate the effects of a flood proofing measure.

Uplift: The hydrostatic pressure caused by water under a building. It can be strong enough to break through a concrete basement floor or float a frame house.

Velocity: The rate or speed that water flows, usually expressed in feet per second (fps). While flood proofing measures can be designed to withstand higher velocities, people should not be allowed in floodwaters with a velocity greater than three fps.

Watershed: An area that drains to a single point. A river's watershed includes all the ground that drains to it.

Wet flood proofing: Measures designed to minimize damage to a structure or its contents by water that is allowed into a building.

Flood Proofing References	FLOOD PROOFING TECHNIQUES							PROGRAMMATIC ASPECTS				
	Relocation	Elevation	Berms and Walls	Dry Flood Proof	Wet Flood Proof	Basements	Emergency Measures	Government Programs	Regulatory Standards	Economic Analysis	Hazard Data	Bibliography
PUBLICATION												
Flood Proofing Performance	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flood Proofing Regulations	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flood Proofing: How to Evaluate your Options	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Dry Creek Flood Proofing Success Story	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flood Proofing Technology in Tug Fork	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Local Flood Proofing Programs	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flood Proofing Systems & Techniques	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Raising and Moving the Slab-on-Grade House	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flood Proofing Tests	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Mitigation of Flood and Erosion Damage	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Engineering Retrofitting Manual	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Design Manual for Retrofitting	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Repairing Your Flooded Home	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Elevated Residential Structures	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Flood Proofing Nonresidential Structures	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Coastal Construction Manual	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Manufactured Home Installation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
State and Local Programs	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
National Directory	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Many aspects of protecting basements are covered in the publications under dry or wet flood proofing

**Government
Programs**

AGENCY	PROGRAMS						Comments
	General Information	Technical Assistance	Regulation	Financial Assistance	Projects	Research	
Army Corps of Engineers	■	■		■	■	■	<i>Projects have been elevation and relocation</i>
Federal Emergency Management Agency	■	■	■	■	■	■	<i>Funds are for insured and uninsured buildings</i>
Natural Resource Conservation Service	■	■		■	■		<i>Primarily for rural areas</i>
Small Business Administration				■			<i>Post-disaster loans</i>
Department of Housing & Urban Development				■			<i>Primarily to improve housing conditions</i>
Association of State Floodplain Managers	■					■	<i>Major effort is dissemination of information</i>
State Housing Agencies		■		■			<i>Programs mostly for local officials</i>
State NFIP Coordinators	■		■				<i>Activities vary from state to state</i>
Local Building Departments	■		■				<i>Activities vary</i>
Housing & Planning Agencies	■	■	■	■			<i>Activities vary</i>

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